

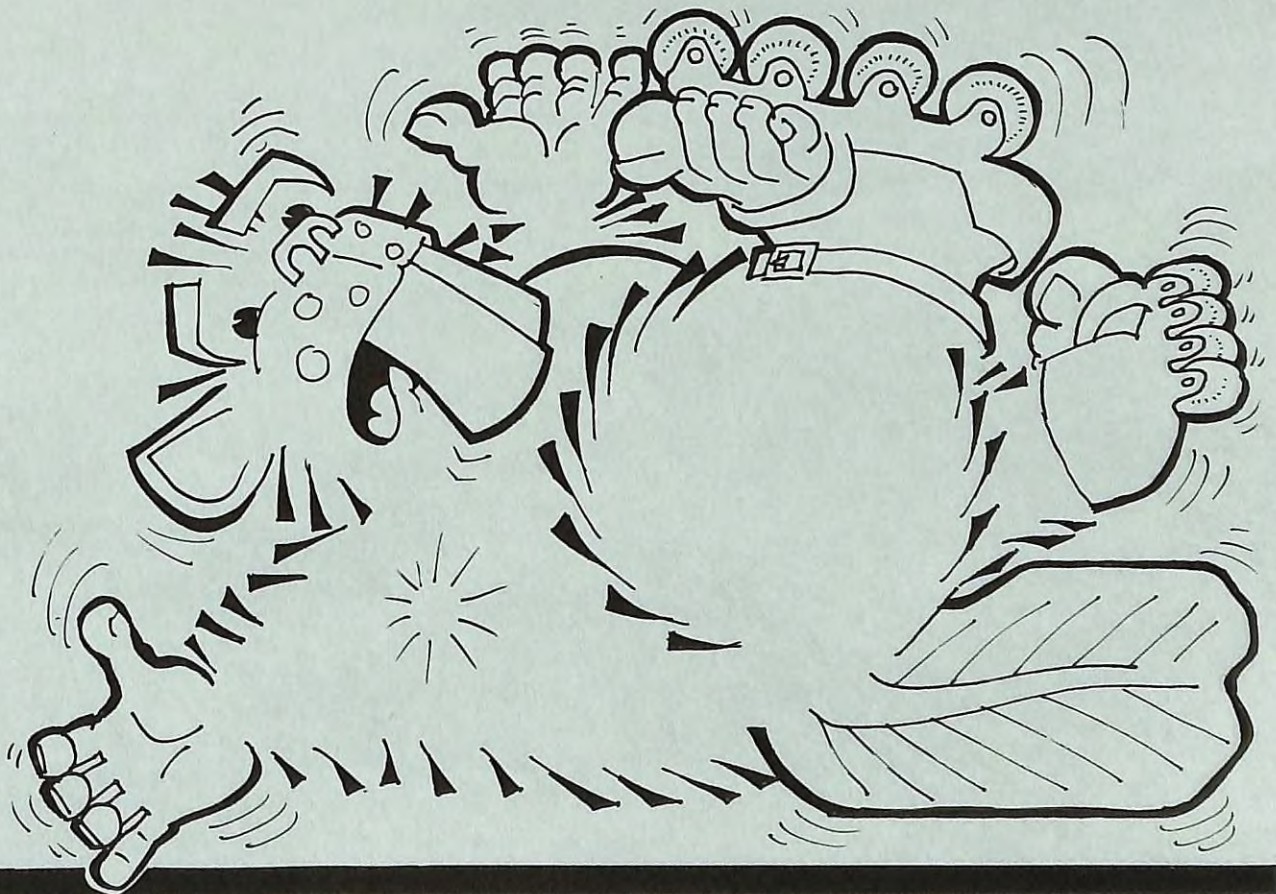
solplan review

the independent journal of energy conservation, building science & construction practice

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Footings



From the Editor . . .

Codes and regulations are something that we can't seem to get away from. There's lots of them, and we're not sure we need more. You've probably said many times that "we need to get the government off our backs!"

But we are also social creatures living in communities. We are not always completely honest, and may try to take advantage of any situation. That is why we establish rules to govern our conduct. Remember the movie *Lord of the Flies*? It was fiction, but what made it so powerful was that it is a mirror on our behaviour.

How so? We set up communities and establish regulations. In the absence of reason, the law of the jungle (and the absurd) takes over. We complain about codes and other building regulations. But look at the regulations that people gladly subscribe to when they move into a co-operative or condominium project. The regulations go far beyond what any self respecting, power hungry, rule happy bureaucrat would ever dare dream up!

What this is all leading up to is the current concern about the new energy requirements that are being proposed. Most agree that a basic code governing minimum health and safety standards is necessary. The debate starts when you try to draw the line between the minimum and what is considered as good or better practice. There are strong pressures to incorporate more regulations that are better described as meeting social goals. That is the way that security requirements, handicapped standards, energy requirements, etc. are introduced.

The concerns being expressed against the proposed energy code seem overstated. The argument against these requirements is that it may affect affordability, the feeling is that the marketplace should decide what is done. Yet those who have seen the proposed standards say "we already do those things".

If the majority of builders are already building to those standards, then why worry? What the code will do is cover the actions of those fast buck operators who skimp on everything. The point is that before you panic, it's worth looking at what is really involved. A reasoned study, with proper discussions is needed.

There are times that societal values must be shifted for the common good, and minimum standards have to be legislated. Think back a few years when mandatory emission standards were introduced in the automobile industry to reduce air pollution. It was regulations that brought about improvements in automobiles auto emissions - not industry - which was foot dragging on introducing changes.

Much is being made about whether the regulations belong in the building code, or some other code. But from a societal point of view, if we have to introduce regulations, does it really matter where they reside? Shouldn't we just deal with the fundamental issue head on? After all, not all regulations are bad. We need them to protect ourselves from ourselves - although hopefully the regulations won't get as ridiculous as some condominium organizations draft up.

solplan review

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Richard Kadulski,
Editor

Foundations

The cost of building a foundation correctly is much cheaper than the cost of repairing a structural defect later. Every structure has to be properly supported. It sounds like common sense yet foundation problems are still a major source of expenditures by warranty programs.

Builders and designers must be familiar with the general principles governing the design of the support for a building. Not paying proper attention to foundation design, or foolishly cutting back on subsurface exploration, can lead to disaster.

Engineering fees are a small price to pay compared to a \$40,000 bill to repair a foundation built on poor soil.

"The foundation" is the term often used to describe the entire structure under the surface of the ground. In fact, this term should be restricted to the structural elements that transfer the load of the building to the earth.

Site Analysis

Key to avoiding foundation problems is the proper identification and assessment of site conditions. Incorrect information can be much worse than no information at all. Poor or suspect soil conditions require special attention. Expert advice is just as important, and much easier to obtain, for the smallest structure as it is for the large buildings.

Compared to larger building types houses represent fairly light foundation loads. Most natural, undisturbed subsoils have more than adequate bearing capac-

ity to support normal house foundations. Problem soils are organic and swampy deposits, fills, wet running sands and soft clays that are usually localized.

A common problem is fill from construction activity. This includes random fills used to raise low-lying ground, backfilling of old excavations or land reclamation. In most cases random fills are not suited to support normal foundations, regardless of the length of time in place.

Foundation Settlement

There are three basic types of settlement: uniform settlement, tilt and non-uniform settlement. Uniform settlement and tilt (within reason) do not greatly affect a structure, although the movements may cause serious problems with services to the building.

Non-uniform settlement is characterized by angular distortion and can cause cracks or major structural failure.

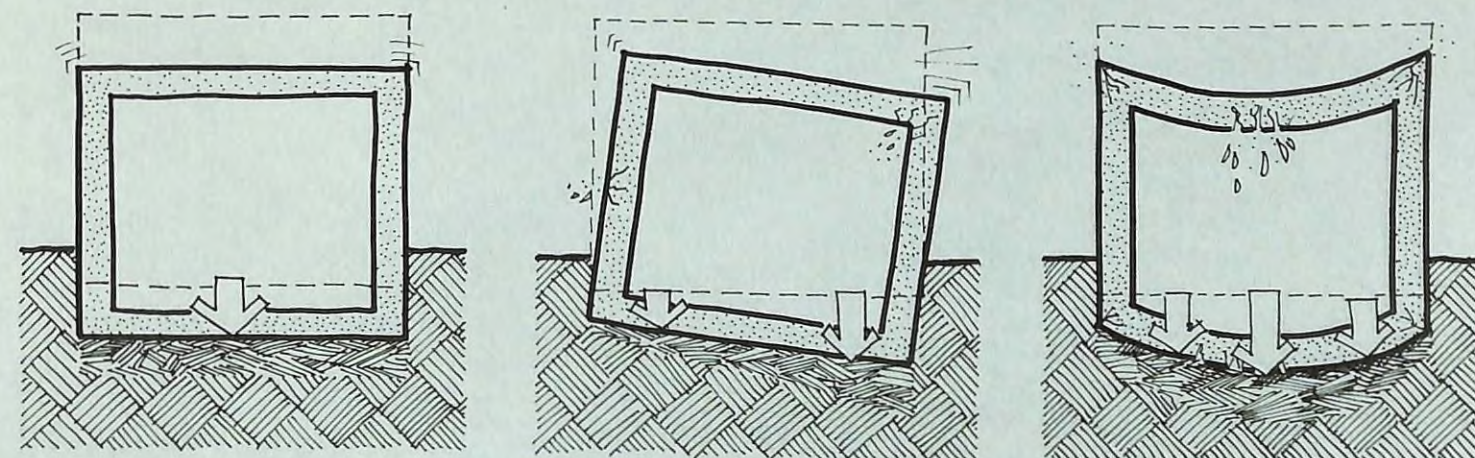
The amount of settlement that a building can tolerate, the "allowable" settlement depends on its size, type and intended use.

Clay soils

Clay subsoil provides satisfactory bearing medium for many buildings. However, many clay soils shrink and swell depending on the moisture content.

Most of the problems with buried pipes, sidewalks and roadways do not result from excessive loading of the subsoil but merely due to the swelling or shrinking of the soil itself. On the Prairies and inland British Columbia the volume changes of clay soils are often caused by the side effects of construction and landscaping activities as these disrupt the natural moisture equilibrium that exists.

Swelling and shrinking can be so great that it can move a building, sometimes with disastrous results. Winnipeg area soils have so much swelling some have said that instead of building permits, buildings should be licensed as mobile homes!



Many cases of foundation problems caused by swelling and shrinking soils have been observed by the National Research Council. Some of the more remarkable cases of foundation movements happen as a result of seasonal volume changes in the subsoil. These may be caused by drying and shrinking due to vegetation, to swelling of some clay materials following excessive wetting, or to heaving by freezing or settlement by thawing. Freezing and thawing must be considered a hazard both during and after construction.

One bad case happened on the prairies where a floor in a shallow basement heaved at a continuing rate of almost 1 inch per year. When the building was examined the floor had heaved more than 2 ft., while the wall footings, which are more heavily loaded than the floor, had only heaved 5 inches.

On many tree-lined streets in Western Canadian cities, the bowl-shaped depressions in sidewalks, roadways and landscaping, (often a foot or more), and foundation distortions are evidence of progressive shrinkage settlements.

The effect of lawn watering and plumbing leaks on subsoil moisture conditions also can contribute to problems.

Foundation Design

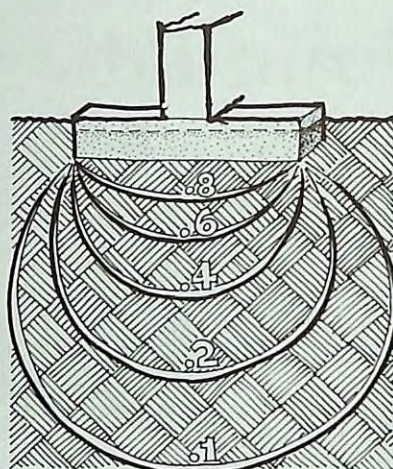
Specially designed foundations are required when random falls or weak compressible soils are present at the foundation level. Detailed foundation design should be done by experts.

The design of foundations consists of three essential operations:

- 1: Calculating the loads that must be carried to the supporting soil;
- 2: Determining the character of subsurface conditions, including groundwater conditions, to a depth at least twice the width of the structure;
- 3: Designing a foundation structure that will safely transfer the loads from the structure to the foundation beds that have been found at the site.

Whatever type of foundation structure is used, it must carry the load from the building to the ground safely in such a way that the finished structure will perform as intended. The bearing capacity of the soil or rock must not be exceeded.

The loads to be transmitted to the foundation beds must be known with reasonable accuracy early in the design stage. Equally important it is important to know the character of the supporting



around to a depth of at least twice the width of the anticipated foundation structure, and preferable deeper than this.

A common error in design is forgetting to take into account the loads added to the ground by even small earth fills on the site. Two or 3 feet of fill may equal the weight of the structure and serious settlement may be caused by the combined load.

The load transmitted from the foundation structure can be regarded as gradually "spreading itself" in the ground in all directions. As the distance from the structure increases, the intensity of stress steadily decreases. Foundations for small build-

ings are usually based on local traditions. Many local designs have evolved through modifications of conventional designs brought from other areas.

Spread footings placed at depths ranging up to 8 feet below original grade are commonly selected for small buildings with basements. However, the root penetration of large trees and drought-resistant plants may go well below this level and could eventually affect the soil volume thus impacting on foundation performance.

All loose, softened and disturbed soil within footing forms must be removed by hand prior to pouring concrete. Disturbed soil left below the footings will tend to become saturated and soft resulting in possible minor foundation settlement. Mud, excess water and, especially, any frozen soil must be removed from footing locations.

Wet, sandy subsoils are prone to be runny, causing excessive disturbance by the excavation. It is best to maintain basements above the permanent water table. Where seasonal water conditions exist, due care and ground water control, measures are required to minimize base disturbance.

Engineered Fill

Often "engineered" fill is used in new developments to raise low lying ground. This involves initial removal of topsoil or other unsuitable material, followed by controlled placement of well compacted fill.

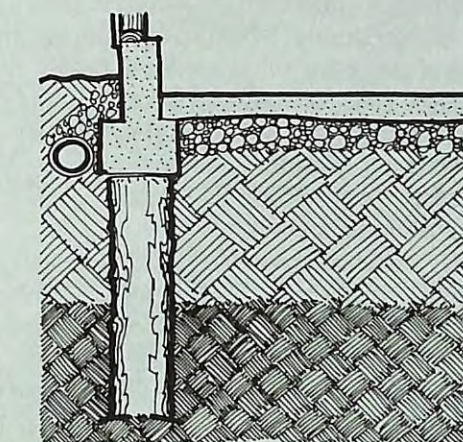
Structural Slabs

Slab-on-grade foundations can be designed in various configurations depending on soil and climatic conditions. The slab-on-grade is designed to distribute the structural load over the entire slab area, thus reducing concentrated or point loads. Structural reinforcement within the slab allows it to act as a monolithic unit.

Slab-on-grade foundations can upset the natural transfer of moisture to and from the ground and for this reason they are subject to annual as well as long-term movements. Annual cyclic edge movements of an inch or more, and net edge heaves of more than 5 inches over a period of several years, have been observed. Spectacular heaves at rates of 3 inches or more per month have been observed due to plumbing leaks beneath light industrial or residential slabs - especially if frost penetration happens.

Although not commonly adopted for small buildings, raft foundations might be considered in some cases.

Slab-on-grade for small basementless buildings have met with varying success in different areas of Canada. They are very common on the West Coast, especially in high water table areas, and any other area with little frost penetration.



Pile Foundations

When the depth of poor soil to be excavated is excessive, pile foundations are often used. Piles provide bearing support down to the underlying bearing soil level. They provide point support for grade beams. The stability of the piers and beams largely depends on the height of the piers and the bearing capacity of the soil at their base. Pile foundations usually require input from geotechnical and structural engineers.

Foundation walls must be designed as a reinforced, rigid frame to span between piles. The basement floor may also need to be designed for pile support.

Winter Construction

In most parts of Canada the ground freezes during the winter months to depths varying from a few inches in mild areas to several feet in colder regions. Ground freezing can lead to heaving of buildings located above or adjacent to it.

Checklist For Preventing Foundation Problems.

- ☐ Ensure that the bottom of the excavation is never allowed to freeze during construction
- ☐ Geotechnical studies are generally advisable and mandatory for any known problem sites.
- ☐ Encourage site staff to be alert for any unusual conditions
- ☐ Arrange necessary inspections by local building authorities and geotechnical specialists when uncertain conditions are encountered. (Better safe than sorry!)
- ☐ Design special foundations in accordance with established local practice and as specified by the engineer.
- ☐ Provide free-draining backfill or a slip membrane around the basement. The slip membrane should be continued around the garage.
- ☐ Follow good construction practices at all times, keeping foundation surfaces clean before placing concrete.

Causes of Foundation Settlement

Severe foundation settlement is usually the result of improper soils investigation before starting construction. Investigation can usually identify inherently poor subsoil conditions. Design flaws or improper construction practice can also be a cause of foundation problems.

Design Deficiencies

- ♦ Weak or unstable natural subsoils
- ♦ Unknown random fills
- ♦ Improperly constructed engineered fills
- ♦ Absence of slip membrane or free draining backfill in soils subject to frost adhesion.
- ♦ Extremely long, straight basement walls without intermediate buttressing.
- ♦ Improper sizing of footings
- ♦ Inadequate frost depth

Poor Construction Practice

- ♦ Inadequate frost protection before and after foundation construction.
- ♦ Excessive base disturbance
- ♦ Absence of proper ground water control
- ♦ Undermining by sewer trenches
- ♦ Improper or early backfilling
- ♦ Inadequate hand cleaning of disturbed material from founding surfaces
- ♦ Failure to remove frozen soil resulting from inadequate frost protection

The conventional approach to prevent frost damage is to place the foundation beyond the depth of the expected maximum frost penetration. This alone, however, does not necessarily prevent frost damage; if the excavation is back-filled with frost-susceptible soil it may lead to damage from adfreezing.

For frost action to occur three basic conditions must be satisfied: the soil must be frost-susceptible; water must be available in sufficient quantities; and cooling conditions must cause soil and water to freeze. If one of these conditions can be eliminated frost heaving will not occur.

By their very nature frost-susceptible soils do not drain well. Subsoils most affected by frost are soils such as clay silts and silty sands with a high moisture content. Prolonged freezing exposure of these soils will result in significant heave due to the formation and growth of ice lenses. It is very important to protect the open excavation, particularly the footing areas, from frost.

In general, coarse-grained soils such as sands and gravels do not heave, while clays, silts and very fine sands will support the growth of ice lenses even when present in small proportions in coarse soils. If frost-susceptible soils located

where they will affect foundations can be removed and replaced by coarser granular material, frost heaving will not occur. Where proper drainage is prescribed water can be prevented from reaching the freezing zone in frost-susceptible soils.

It is commonly thought that straw is the best cover to adequately protect an excavation from freezing. In reality, the straw only retards heat loss. The development of a frost crust in excavation bases is very common during winter construction even if there is a deep straw cover. The protection given by the straw is significantly diminished during cold snaps or over extended periods of time. Cold air is more dense than warm air and flows into the spaces below ground level, accelerating the extraction of heat from the soil behind the retaining structures.

Frost heaving and damage frequently occurs on construction sites in early winter because temporary heating is not begun early enough.

Interior footings, which are often placed only a few inches below basement floors, are especially vulnerable to frost action at such times. The walls and floors of a partially completed structure act like cooling fans to accelerate the extraction of heat from the ground.

In recent years, insulation has been used extensively to reduce ground heat loss and hence depth of frost penetration. With the installation of the right thickness of insulation on the appropriate surfaces of the foundation or in the soil, soil temperatures can be kept above the freezing point.

Loss of heat from basement spaces through the surrounding soil reduces the depth to which frost penetrates in the immediate vicinity of a building.

You don't always have to dig deep, below the frost line for a foundation. Next issue we will discuss frost protected shallow foundation designs.

Garages

Frost heaving can occur if inadequate heat is supplied during cold snaps or if garage doors are left open. Concrete floors may be lifted and shallow foundations heaved. The foundations beneath all the walls of basement garages should be placed at depths beyond maximum frost penetration, properly backfilled and drained or protected from freezing by the use of insulation.

Baseclad: Use it or lose it.

Almost 10 years ago (Solplan Review No. 4) we described a new product called *Baseclad*, a rigid fibreglass insulation board for use in insulating and water proofing foundations.

Baseclad is an inorganic - non-corrosive insulation board that has been marketed by Fibreglass Canada.

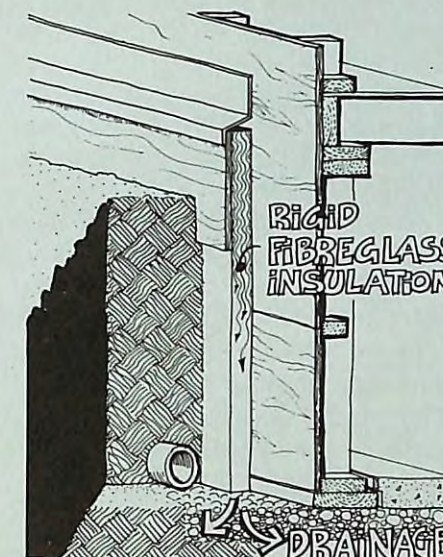
Why do we like *Baseclad* so much? It is a product that does double duty - it waterproofs and insulates foundations at the same time.

The principle is simple: as the fibres run parallel to the surface, any ground water finding its way to the *Baseclad* will run down the surface of the insulation board - so that only the surface is wet. The balance of the board remains dry. The surface thus acts as a drainage layer.

We've now learned that Owens Corning/Fibreglass Canada Inc. have removed *Baseclad* from their catalogue, although it will still be made to order. In its place, they have launched a new thin version called *Drainclad*. It has been designed and manufactured specifically to meet the drainage requirements of the July 1, 1993 amendments to the Ontario Building Code.

Composed of high density glass fibre, the resilience of *Drainclad* allows it to conform to irregularities in basement wall surfaces. Once installed *Drainclad* boards resist impacts that could otherwise damage dampproofing membranes or permanently indent other non-fibrous drainage systems.

Drainclad Foundation Drainage Boards are 4' x 6' x 3/4". The top of the boards is to be nailed or adhered in contact with the wall prior to backfilling, using 1 1/4" concrete nail with a 3/4" diameter washer.



A conventional crushed stone drainage system and drain tile system is still used. The foundation can then be back-filled with on-site excavated material using normal equipment and operations.

Drainclad boards are designed only to provide drainage for foundation walls by channelling ground water to the foundation drains. Unfortunately, this thinner version provides no insulating value. Evidently, it would appear that plans are to drop the manufacture of the insulating board in the future.

The message is clear, if you want *Baseclad*, you must use it or lose it. *Baseclad* is an excellent product for basement insulation that deserves to be marketed properly.

For information contact the Owens-Corning/Fibreglass Canada Inc sales office nearest to you or:

Owens-Corning/Fibreglass Canada Inc
310 Humberline Drive, Unit 2
Rexdale, Ontario M9W 5S2
Telephone: (416) 675-3070
Fax: (416) 675-4631

NCAT Wraps Up Energy-Related Toll-Free Help

The National Centre for Appropriate Technology (NCAT) has ended a 10-year stint as the U.S. Department of Energy's primary source of detailed technical assistance for renewable energy and energy efficiency technologies.

NCAT, a nonprofit organization, has operated from its Butte, MT headquarters since 1984. The Department of Energy (DOE) began sponsoring the toll-free service when NCAT proposed it as a logical extension of the work of its energy program.

Through the National Appropriate Technology Assistance Service (NATAS), NCAT energy specialists responded to more than 80,000 requests from every state in the U.S.. Requesters asked for information to help them implement projects that used renewable energy or energy efficiency technologies. NCAT technical specialists advised on how to use solar, wind, biomass, hydro, and geothermal energy sources to replace fossil fuels.

Specialists also helped many Americans build more energy-efficient homes and businesses with advice on the latest materials and techniques for insulation, heating and cooling, appliances, lighting, and windows.

This service allowed NCAT to have a national outreach and a national impact on how these emerging energy technologies are used by individuals, small businesses, and state and local governments throughout the U.S..

NATAS employed 25 professionals and support specialists at NCAT, most of whom have been reassigned to work on other energy-related projects.

NATAS, the U.S. Department of Energy-sponsored service that provided detailed technical assistance on renewable energy and energy efficiency technologies, has ceased operation.



Letters to the Editor

Sir,

Re: Water Conservation (Solplan Review, #53)

I found your article on water conservation very informative.

We have developed a water saving device which can be retrofitted to a standard toilet to provide up to 60% water savings. As you are probably aware, many of the 6 litre toilets are quite expensive compared to less efficient models. Our retrofit device retails for only \$20.00 and therefore is a more economical solution (and good for retrofits of existing toilets).

We call it the 1-2 Flush by Water Wizard. It's a modification kit for the standard flush valve that offers two options: Lift the handle for a low flush, push the handle down for a standard flush. We are beginning marketing in the Metropolitan Toronto area.

R.L. Hooshley
Concord, ON

Readers wishing more information:
Water Wizard, Ste. 2003, 1700 Langstaff Rd
Concord, ON L4K 3S3
Tel: 905-669-5571, Fax: 905-669-2134

Sir,
"Carpets and Indoor Air Quality" (Solplan Review #54) points out that ethics waver in a commission sales environment.

At risk of defending every fast talking hustler who's donned a plaid jacket, I beg to disagree. Ethics waver with the strength of a person's character not with how they're paid.

Stephen Thwaites
Thermotech Windows Ltd
Ottawa, ON.

Product Review Rubberloc™ Pavers

Used car and truck tires are a problem everywhere. The space that old tires take up in landfills only makes an existing waste problem even worse. In addition, the noxious emissions from fire is a threat when these tires are left in growing piles in dumps and scrap yards.

Innovative Waste Technologies Inc. is a Vancouver based company that recycles truck and auto tires into a variety of rubber based products using a proprietary non-polluting process. They chop tires into small, rubber granules which can be turned into new products, such as running tracks, rubber flange fillers for level railway crossings, air mattresses, cushion playground pads, car battery cases, rubber mats, loading dock pads and carpet underlay.

They are the largest processor of scrap tires in Western Canada, recycling about 70,000 tires a month at their New Westminster, B.C. plant. Of special interest to builders is one of the company's products: **Rubberloc™**, a unique and aesthetically pleasing paving brick. The process used in the making of the rubber pavers is non polluting.

Unlike concrete pavers where there is loss due to breakage during delivery and installation, this is not the case with the rubber pavers.

The paving bricks are half the weight of concrete or clay blocks and are available in several colours. They are durable, recyclable and do not shrink, leach, or breakdown. The surface of the pavers is less abrasive than that of concrete pavers.

The pavers are stain resistant and easy to clean. Industrial strength cleaners, and even acid and alkali, will not react with the pavers.

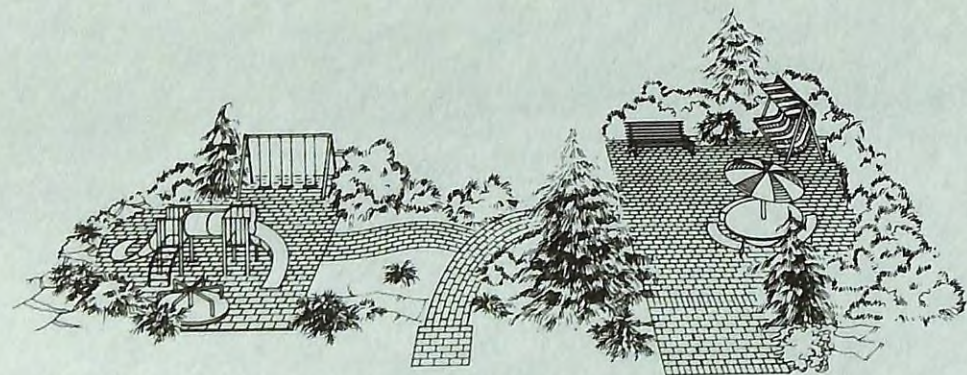
Because the surface is softer and has some "give", it is far more comfortable to walk and stand on and easier on the feet. Dishes and glassware are more likely to bounce than break if dropped, making this something to consider for patios and decks, around swimming pools and hot tubs or anywhere else that outdoor entertaining is desired.

Due to the energy absorbing properties of the rubber, injuries from falls may be less serious and less traumatic. This forgiving nature of the rubber pavers makes them attractive for use anywhere that children may be present.

These pavers were used in the patio of the **B.C. Advanced House**, and have received a lot of positive attention from visitors.

Cross Canada marketing has started, and the product should be available at major building suppliers throughout Canada.

For Information:
Innovative Waste Technologies
100 - 1 Grosvenor Square
New Westminster, B.C. V3M 5S1
Tel 604-524-5263



Northeast Sustainability Centre

Sustainable development sets out a challenge: how can each generation provide for its own needs without compromising the ability of future generations to provide for theirs? The Northeast Sustainable Energy Association (NESEA) has begun planning and design of the Northeast Sustainability Centre.

This centre will house NESEA's offices, library, resource materials, and meeting place. It will also demonstrate environmentally responsible building appropriate for the 21st century. The building will be a laboratory, a place to conduct research and will be a useful tool to educate the public about sustainable building, transportation, energy use, and economy; as well as providing a centre for the NESEA community.

A site in Western Massachusetts are being considered.

NESEA, is a nonprofit membership organization that has fostered responsible energy use for a clean environment since 1974.

Information:
NESEA, 23 Ames St., Grenfield, MA,
01351 Tel: (413) 774-6051, Fax:
(413) 774-6053

The Global Marketplace: Buyer Beware



In the era of the Global market place a lot of product moves across international boundaries. Building products which may not conform to Canadian codes or Canadian Standards can easily be imported.

Canadian codes and standards have contributed to the high quality of housing enjoyed by Canadians and it is in the interest of Canadians that this quality be maintained. However, the free trade agreements may be undermining this as there is a requirement to provide access to foreign products. Restricting imports of non-conforming U.S. products at the border does not appear to be a realistic option. If the regulations are perceived as a non-tariff barrier, then the legal beagles will pounce.

Harmonization of standards between the U.S. and Canada would appear to be the ultimate solution to the problem as U.S. products manufactured to lower standards cannot easily be excluded from the Canadian market.

Where Canadian standards are higher, Canadian manufacturers incur extra costs to ensure that their products meet these higher standards. Canadian manufacturers have expressed a concern, that competing against products made to different or lower standards is not fair competition.

To deal with concerns raised by Canadian manufacturers, Industry and Science Canada examined the issue. A number of products were looked at in detail.

Steel studs:

The volume of imports of steel studs has fallen off recently. U.S. standards are inferior, a fact not understood by many contractors or building officials. U.S. Steel studs may use undergauged steel as well as galvanizing which is less than the Canadian requirement.

Insulated steel doors:

As the Canadian dollar has fallen in value compared to the U.S. dollar, imports have been reduced to "insignificant amounts". The issue is

that some U.S. product is prone to earlier rusting. Some U.S. steel door suppliers use undergauged steel which is not properly galvanized. Most users, contractors and building officials are not aware of this and as it is difficult to detect on new doors. Labelling of doors, combined with education, would appear to be the most effective solution.

Residential windows:

Some U.S. residential windows do not conform to Canadian codes and standards for air, water leakage and resistance to forced entry. Improved labelling of windows, and education of contractors and building officials would be beneficial. Industry is already moving on a labelling program.

Vinyl siding:

Alleged to be below acceptable thickness to meet Canadian codes and standards. However, problems are not restricted to U.S. imports. Price is a key consideration. Labelling and education of building officials are important.

Fibreglass insulation:

There is a difference in real R-value of 10-15% between U.S. and Canadian products for the same labelled thermal resistance.

Gypsum drywall:

The certification process in the United States has eliminated the need for minimum weight standards, while in Canada this amendment has now been eliminated in the CSA certification process. Industry officials claim the U.S. product is not inferior.

Toilets:

Random tests performed on imported toilets by Canadian manufacturers have indicated many imported toilets may not pass the CSA-B45 standard for toilets in Canada.

Plumbing fittings:

Plumbing fittings and fixtures imported for retail sale are frequently of lower quality and reliability than the products traditionally sold by Canadian manufacturers. Imported faucets do not always conform to Canadian standards in terms of flow rates, material specifications, cycle tests and physical dimensions of the faucets.

Plastic pipe:

According to Canadian manufacturers, imported plastic pipes contain cellulose which may make the product brittle and fracture in cold temperatures. Because of this they may not meet CSA standards.

Part of the problem is that some domestic products also do not conform to certain codes and standards.

In Canada we legislate, in the U.S. they litigate. This "buyer beware" system makes it difficult to compare equivalencies for U.S. products, as consumers tend to look for brand names and the brunt of liability for faulty products is borne by builders and manufacturers, rather than code officials.

The solution is more education of builders, code enforcement officials and consumers, and proper labelling to clearly identify products. The labels should include identification of standards.

In sum it comes down to buyer beware! If you stick with known domestic products, you should not encounter substandard products, as well as helping Canadian industry (who are you customers too!).

Grey Water Systems: The Light Grey Option

Mention water conservation and Grey water use is raised. A few of the Advanced Houses looked at heat recovery from Grey Water. A recent study for CMHC investigated re-using greywater. Work on this is still at the concept stage, but it provides an interesting window on what we will be seeing in the future.

What is grey water?

It is the waste water from bathing, washing and dishwashing. If the grey water is handled properly it offers the potential of further reducing potable water use by 30 - 40% once state-of-the-art conservation devices are installed in a home.

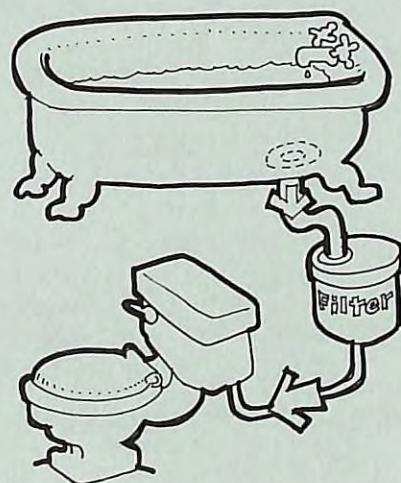
The **Light Grey Option** for domestic water conservation advocates greywater reuse for non-portable uses. The benefits of reclaiming wastewater are to supplement available water resources and to enhance water pollution abatement. On a national basis, domestic water consumption is about 350 litres per capita per day. Using grey water has the potential of substantially reducing this consumption.

A report commissioned by CMHC provides a concept review of the feasibility with respect to

- 1) greywater treatment requirements;
- 2) availability of potentially suitable greywater treatment systems,
- (3) public acceptance.

The term Light grey option has been applied to this concept. By means of a dual piping system, the Light Grey Option proposes to collect used bathing water, clotheswasher rinse water and dishwasher rinse water for simple treatment. The treated greywater would be then reused to: flush toilets; provide washwater for the clotheswasher and dishwasher; and to irrigate lawns and gardens on a seasonal basis.

Taking advantage of grey water will require some modification of clothes washers and dishwashers to accommodate dual



water supplies (treated greywater for washing and potable water for rinsing). It also requires the development of acceptable greywater treatment systems. A detailed cost benefit analysis once the technology is in place will determine whether there are enough water savings to justify the Light Grey Option.

Because of the preliminary nature of the project no attempt was made to develop cost estimates at this time.

In a typical Canadian four-person house equipped with state-of-the-art conservation devices including European designed clothes and dishwashers, the amount of water generated for treatment by the Light Grey Option is expected to range between 200 litres per day (lpd) and 380 lpd. The average amount of water for reuse would be between 130 lpd and 240 lpd.

A key issue with grey water systems is how much treatment the grey water needs. Reusing greywater for toilet flushing and irrigation raises the possibility of expo-

sure to pathogens. Precautions may have to be taken by the residents to minimize body contact.

Compared to conventional greywater, Light Grey greywater is low in total suspended solids and biodegradable organics. These qualities may impact negatively on some treatment processes.

The main water quality considerations are aesthetic concerns for the control of turbidity, colour, odour and staining. Foaming must be avoided. Volatile organics must be vented under controlled conditions, and some effort will have to be made to keep objectionable household cleaning and cosmetic products out of the greywater system.

Many hazardous organic chemicals are also found in residential waste water. These include solvents, paint thinners and degreases, methylene chloride, benzene and toluene, pesticides such as DDT and lindane, incomplete combustion products called PAHs and plastic components. In toilet flushing there will be some release of volatile chemicals into the air by evaporation.

Commercial products used in the home may present public health problems and may have the potential to impact adversely on greywater treatment systems, especially biological processes. Products of concern include heavy metals, organic chemicals and volatile organics.

The technological and engineering concepts of wastewater reuse are becoming increasingly well understood and accepted, especially at the municipal and commercial scale. Demonstration sites for light greywater may best be done on multiple housing units on municipal sewers, at this would minimize downsizing requirements.

Treated residential greywater reuse for either surface or subsurface urban landscape irrigation is already approved in Texas and California.

Texas has permitted reuse of water from bathtubs, showers, sinks and washers since 1989 for surface or drip irrigation. The required treatment consists of filtration and storage.

California legislation came into effect July 1, 1993. Greywater from showers, bathtubs, bathroom wash basins, clothes washers and laundry tubs may be used for residential subsurface irrigation, but wastewater from kitchen sinks and dishwashers cannot be used.

A number of different, suitable greywater treatment facilities can be developed from present experience and available proprietary equipment to meet the needs of the Light Grey Option, but more study will have to be done on this area.

Treatment Processes include sedimentation, holding tanks, biological processes rack filters to pretreat greywater, and filtration. Granular-media filtration, such as used for swimming pools, removes the majority of suspended matter remaining after biological treatment.

Disinfection/Chemical Oxidation possibilities include Chlorination, Ozonation, and Ultraviolet Light. UV light devices are potentially effective, reliable, and have the advantage that they do not leave any residual taste or chemicals that react with other substances in the water.

Solar Aquatics are based on plants, sunlight and natural biota in the form of artificial wetlands and greenhouse systems.

Further action will have to consider what modifications have to be made to appliances and plumbing systems, what are suitable greywater treatment technologies, and proper testing of components. It will be important to do demonstrations to test new options and to win public, health and consumer acceptance.

*The "Light Grey Option": Making Residential Greywater Reuse Happen
Prepared for: Research Division
Canada Mortgage and Housing Corporation by: A.R. Townshend, P. Eng.*

Window Ratings

Windows are a complex component of the building envelope. Many options are offered by window manufacturers, and competing claims often make it difficult to come to a well-reasoned decision when purchasing.

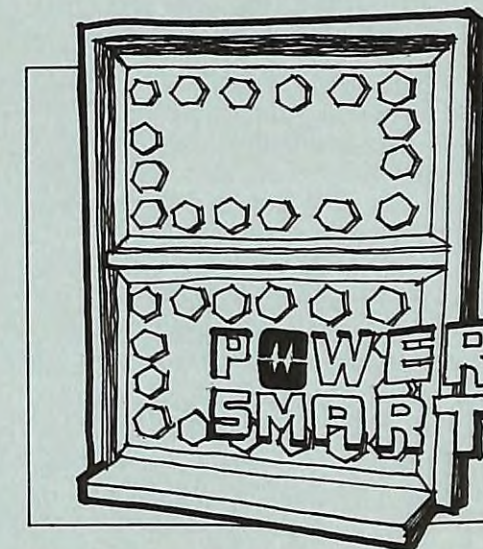
Too often the easiest decision is to select the windows based on the lowest first cost, even though this may be the poorest choice.

Heat loss through windows

Heat loss is influenced by the area of glass, the emissivity of the glass, the thermal conductivity of the spacer bar, the number of "air" spaces, the decorative bars in the spaces (muntin bars), the frame material and frame design, and the way the glazing unit is mounted in the frame. The heat loss, known as the U-value (the reciprocal of U (1/U) is the overall R value), can be defined by a single number derived from laboratory testing or computer simulation.

Air infiltration

Fixed or picture windows can be airtight, but windows with opening components inevitably will leak air. Weatherstripping is the conventional answer to air leakage problems, but just as all windows are not created equal, neither is weatherstripping. The CSA A440 standard determines an air leakage level for windows. This is the "A" test, and on the labels on new windows you will see ratings of A1, A2, or A3. (The BC Building code presently requires the minimum A1 level.) Cold air infiltrating or warm air exfiltrating through a window will contribute to heat losses.



Energy Ratings

Builders in Ontario will be well aware of window Energy Ratings (ER numbers) as they were a key component of Ontario Hydro's window incentive program for the past 2 years. Now BC Hydro in co-operation with the Window and Door Manufacturers Association of B.C. has developed guidelines for labelling windows as Power Smart. This should encourage the development of a market demand for more energy efficient windows.

The window Energy Ratings (ER) numbers make it easier to make energy performance comparisons between windows. The rating procedure is now a part of the CSA Standard A440.2. It takes into account solar heat gains, heat losses through the window and air infiltration losses. The ER numbers are derived by calculation, not testing, and are determined by subtracting transmission losses and air infiltration losses from the solar gains:

$$ER = (\text{solar gains}) - (\text{transmission losses}) - (\text{infiltration losses})$$

Because the losses for most windows are more than the gains, most ER numbers are negative, although some very

efficient windows can have positive ER numbers (which means that they could be net energy gainers).

ER numbers do not tell you exactly how much energy the windows in a given home will actually lose; that is a more complex analysis which involves the direction the windows face, the house location and climate. Rather the ER numbers are a way to compare the energy efficiency performance claims of different window products on an equivalent bases, not unlike the fuel consumption ratings for cars or Energuide labels on appliances.

For example, window 1 and window 2 may both have Low-E glass, insulating spacers and thermally broken metal frames. If window 2 has a better thermal break and an A2 rating while window 1 is A1, window 2 would have a better ER than window 1 because of features that you can't see.

On the other hand, if window 2 had an A1 air leakage rating and window 2 had an A2, the ER situation might be reversed or it could be equal. Add another three or four variations and the value of ER becomes obvious - you only need to compare a couple of numbers rather than half a dozen individual features, many of them invisible and hard to judge.

In B.C. the typical window used is double glazed with a 1/2" air space, metal spacer bar and air between the glass. In the coastal areas (Lower Mainland/Vancouver Island) metal frames with thermal breaks have only become common with changes to the building code early this year. Before that, regular non-thermally

broken aluminum frames were most common. Wood or vinyl is common in the rest of the province.

Typical ER numbers for such windows are:

Movable sash, metal frame with good thermal break	ER -35 to -38
Fixed window, metal frame, thermally broken	ER -28 to -30
Movable sash, good quality vinyl frame	ER -20 to -24
Fixed window, good quality vinyl sash	ER -15 to -17

Fixed or picture windows have better (less negative) ER numbers than movable sash windows because fixed windows have little air leakage.

Because of the diversity of climate zones in B.C. two climate zones with differing standards have been defined. Climate zone 1 is the mild coastal area (Lower Mainland, Sunshine Coast and Vancouver Island). The rest of BC. is climate zone 2. To qualify for Power Smart Window designation, the units must meet the following requirements:

	Zone 1	Zone 2
Movable sash windows	ER -18	ER -13
Fixed window	ER -13	ER 0

In addition, all must meet CSA A440 levels A3, B3 and C3 and glazing units must have IGMAC (Insulating Glass Manufacturers Association of Canada) certification. Manufacturers must warranty their glass seal against failure for at least five years.

Effectively, this means that all windows will be low-e glass with insulating spacers and possibly argon gas fill.

WINDOW PURCHASING CHECKLIST

When purchasing windows, factors that should be considered, include:

- ☐ heat loss through the glass;
- ☐ type of glass (ordinary, Low-E, tinted);
- ☐ heat gains through the glazing (summer, winter);
- ☐ air space width;
- ☐ type of gas in the "air" space (air, argon or other gas);
- ☐ frame material;
- ☐ spacer material;
- ☐ air tightness (infiltration);
- ☐ resistance to rain penetration;
- ☐ resistance to wind forces and pressure differentials;
- ☐ resistance to forced entry;
- ☐ durability of the frame material;
- ☐ maintenance requirements
- ☐ colour of the frame;
- ☐ durability of the glazing seal;
- ☐ visibility through the glass;
- ☐ warranty;
- ☐ cost
- ☐ ER rating



Canadian Home Builders' Association

Technical Research Committee News

Sprinklers

No, we're not talking about the garden variety, but inside buildings. This issue is not going away! Fire suppression officials are still pursuing their goal of making sprinklers mandatory everywhere.

CMHC and IRC have done more work on the cost effectiveness of sprinklers for multi-family (Part 3) buildings. The results are somewhat surprising, as they indicate that sprinklers in these building types are even *less* cost effective than for single family residences.

Another study that should be started in the near future is a case study of the experience of mandatory sprinklers in the City of Vancouver. It is hoped that this study will investigate the experience of the regulations, including:

- impacts on the building code (mandatory changes were introduced as a result of the sprinkler requirements - one estimate is \$3,000 per house in extra detailing costs),
- impact on City infrastructure (there are extra costs for the city to accommodate increased water flows),
- review operating experiences with sprinklers (what kind of problems have been experienced?)
- feedback from the insurance industry (have there been any changes on insurance rates?),
- extra costs for the city, builders, and home owners.
- review original statements in favour and against sprinklers against experience in the field
- compare impact of fire department call-outs in homes since mandatory sprinklers were required.

Contaminated Lands

As we begin to redevelop more property instead of dealing with virgin land, we are increasingly facing the problem of toxic residues in the soil which may be present as a result of previous uses. This is becoming a serious issue, but it still needs much more work.

We've heard of a case where a truck spilled a small quantity of oil by accident. It meant the property was designated contaminated, and it led to clean-up costs of around \$40,000. The consequences can be severe. (Anybody not have a small spill of something on a job site?).

To make matters worse, there is still no clear consensus what contaminated means, and what standards have to be maintained. At the instigation of CHBA, the Hon. David Dingwall, Minister responsible for CMHC announced that there will be a Federal/Provincial housing officials meeting on April 6-7, 1994 in New Brunswick to try and come to a resolution of how this entire issue should be handled.

CHBA Builder Manual

The latest edition of the builder manual has been substantially revised. It includes the latest information and requirements for the R-2000 Program and also environmental building considerations. The manual is now available from the CHBA office.

CHBA Position Paper on Codes

In the last issue there was a call for comments for a position paper on the direction that codes are taking now. Many comments were received. A final version of the paper that incorporates industry thinking is being prepared, and should be circulated shortly.

CHBA/Canada Trust Environmental Homes Initiative.

A joint venture between the CHBA and Canada Trust will showcase the latest in home building environmental technology in two communities this summer.

Two communities will be chosen shortly for a pilot project. The model homes will be built to the new R-2000 standards and incorporate a range of available, cost-effective environmental features. But unlike other demonstrations, such as the Advanced Houses and CMHC's Healthy House which featured prototype technologies, the CHBA-Canada Trust initiative will feature homes using products which are currently available on the market. These environmental features may extend the "healthy housing" features, as identified by CMHC's healthy housing initiative.

Local home builders' association will manage the initiative, with resources, research and direction from the national office of the CHBA.

After a review period in the fall, the new environmental homes will be offered for sale across the country next year.

Expressions of interest from local and/or provincial associations wishing to mount one of the two pilot demonstration projects this year are being received.

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector. Anyone with a problem, or technical question can

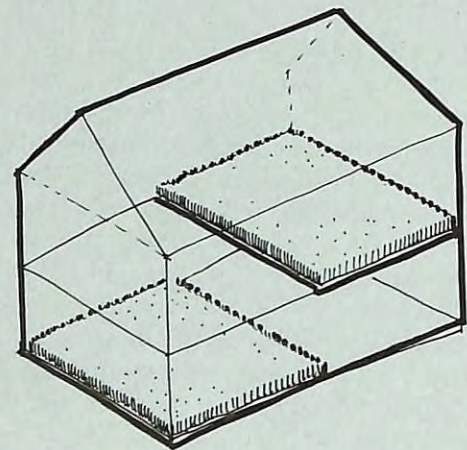
To contact the TRC:
Canadian Home Builders Association,
Suite 200, 150 Kaurier Ave. West,
Ottawa, Ont. K1P 5J4 Tel: (613) 230-3060

R-2000 Indoor Air Quality Requirements

The best way to improved indoor air quality is to reduce the pollution load inside the home. Because of this, the new R-2000 Technical Standards are introducing new requirements for materials used indoors.

How can you tell if the material is going to be bad? It may be an over simplification but if you or the installer get high on a product, or if it stinks, then the product is contributing pollutants into the air. Some products are bad for a short time, and as they cure they become inert. Other products emit volatile compounds for their entire life.

As product labelling is a new concept, the R-2000 standards provide a list of 6 items, only 2 of which must be used. This relates to materials used only inside the air barrier or air/vapour barrier.



2. Air filtration: a medium efficiency air filter with a minimum 10% ASHRAE average dust spot efficiency shall be installed where air circulating heating, cooling or heat recovery ventilation systems are used.

For homes with forced warm air systems, this should be an easy to meet condition, but an air filter will create a pressure drop so the system installer must take this into account when designing the duct work.

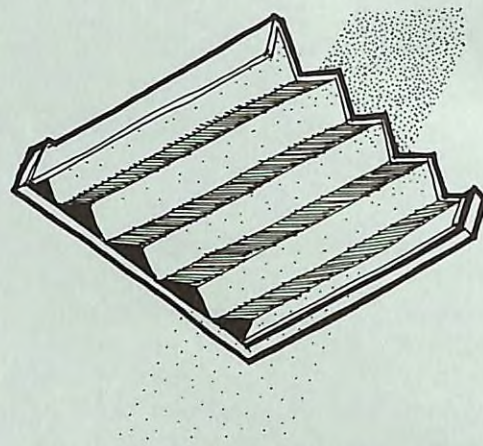
Filters are not usually directly labelled with the ASHRAE efficiency number but manufacturers typically include this information in their product specifications or promotional material.

Filters with a minimum 10% efficiency typically include: electronic air cleaners, media filters, electrostatic filters, high-efficiency particulate air (HEPA) filters and pleated disposable filters.

The easiest and most effective are the disposable pleated filters, a 4" filter can fit in the same slot as an electronic filter but for a fraction of the cost.

In houses with forced air systems the air filter must be integrated with the heating system. Houses which only have heat recovery ventilators (ie. no forced air

Nail strips (tackless strips) can be used as an alternative to gluing.



systems) shall have the filters integrated into the HRV system. Houses with only exhaust fans cannot meet this requirement.

When installing electronic air cleaners, it is important that the flow into the unit be smooth and uniform. Smooth air flow and frequent cleaning of the filter will reduce the production of ozone. A charcoal filter downstream of the electronic air cleaner should move any ozone produced.

Home owners must be advised on the importance of selecting appropriate replacement filters and proper maintenance of the filters.

3. Paints and Varnishes: all liquid coatings used indoors except on wood floors, are to be water based, interior type to meet or exceed Environment Canada Environmental Choice standards. Prefinished items are allowed.

For maximum emission reduction use water-based, low-toxicity products. CMHC's Guide to Healthy Building Materials mentions low toxicity paints and varnishes.

Water and solvent based paints and varnishes which meet Environmental Choice Program standards are labelled

with the Ecologo symbol. Most Canadian manufacturers have products that meet Ecologo standards.

Other paints and varnishes may meet or exceed Environmental Choice standards but are not certified under the Program. This will especially apply to imported products. Your R-2000 office will be able to provide guidance on acceptable alternatives.

Pre-finishing should be done outside of the building envelope and items should be allowed to fully dry and cure in order to limit emissions.

4. Flooring Adhesives: all finish flooring adhesives to be either water dispersion, low toxicity formulations or pre-adhesive types.

Thin-set and thick-set mortars meet this requirement.

Low toxicity adhesives are solvent-free. Examples of these adhesives can be found in CMHC's Guide to Healthy Building Materials

The adhesive must be compatible with the flooring material.

5. Kitchen cabinets and bathroom vanities: cabinets and vanities shall be solid wood or if made from manufactured wood products shall be made from formaldehyde-free fibre board; or particleboard meeting the E-1 European standard or the HUD Standard, 24 CFR part 3280.308; or have all exposed surfaces sealed with an Environmental Choice approved sealer or a low toxicity sealer.

Plywood, medium density fibreboard (MDF) and particleboard are manufactured wood products that meet the requirements. Cabinets made of solid wood also meet the requirement, but it is important to note that many hardwoods have lower natural emissions than softwoods such as pine or cedar which contains terpenes and aromatic resins.

Formaldehyde-free fibreboard is made from softwood chips with a resin binder not containing formaldehyde. Medite 2 is one product commercially available. It is also being used for paint-finish millwork. It's uniform consistency makes it easy to router patterns.

Particleboard meeting the E-1 European emission standard is considered a low-emission particleboard, is used in Europe and is available in Canada.

The Canadian Particleboard Association (CPA) certifies particleboard that meets the U.S. HUD emission standard (24 CFR 3280.308), but it does not necessarily meet the E-1 European emission standard. The E-1 standard requires slightly lower formaldehyde emissions than the HUD standard.

If one chooses to seal the manufactured wood product, all exposed surfaces, (both interior and exterior), must be sealed. On some post-formed countertops this includes sealing the underside of the drip edge. For maximum emission reduction cut outs and perforations should also be sealed.

Laminates (such as melamine) and wood veneers are considered as low volatile content sealers. If a wood veneer is used glues containing urea formaldehyde must not be used to bond the veneer to the board.

6. Wood flooring: all liquid coatings used on wood flooring shall meet or exceed Environmental Canada Environmental Choice standards (for paints) or be prefinished.

A list of certified products can be obtained from the Environmental Choice Program (tel 613-952-9440). CMHC's Guide to Healthy Building Materials also lists suitable products (such as water based urethane). Water based urethane (1-part and 2-part) are specially formulated sealers designed to provide a hard finish for wood floors and can be used as an alternative to solvent based sealers.

Other liquid coatings may meet or exceed Environmental Choice standards but are not certified under the Program (consult with provincial R-2000 office).

Pre-finishing should be done outside of the building envelope and items should be allowed to fully dry and cure in order to limit emissions.

Sources:

Materials ratings is a fast changing area. As soon as a guide is produced, it usually is out of date. Some sources of product listings and information on current standards for healthy building materials include:

Guide to Healthy Building Materials (book) by CMHC (local CMHC office or the Canadian Housing Information Centre Tel. 613-748-2367)

Environmental Choice Program (Ecologo products listing Tel: 613-952-9440)

Builders Environmental Guide (book - CHBA National Office Tel 613-230-3060)

Build Green Program, ORTECH International, 2395 Speakman Dr. Mississauga, ON L5K 1B3

Environmental by Design (book) (P.O. Box 34493, Station D, Vancouver, B.C. V6J 4W4)

The Healthy House Institute (7471 N. Shiloh Rd. Unionville IN 47468)

For some builders, these requirements are breaking new ground. For others, there's very little new. I heard a number of Ontario R-2000 builders complain that the new standards don't go far enough!

For them, the challenge should be to use as many of the items in the pick-list as possible - no need to limit to just 2 items. It is also possible to go much further in terms of technical standards, to use materials with minimum emissions.

RK

The Great Canadian Reno-Demo Project

What is it?

A renovation of a turn of the century house in the City of North Vancouver that will demonstrate the benefits of recycling and adapting existing housing stock, rather than tearing down structurally sound buildings, the current practice in many cities.

The project includes the development of a secondary suite in the basement plus a small addition. Because of the site contours, the suite will be at grade level.

The City of North Vancouver is the first municipal jurisdiction in Greater Vancouver that has legalized secondary suites city wide, thus encouraging the provision of modest cost housing, maintaining neighbourhood character, as well as accommodating an increasing and denser population. A demonstration project that takes advantage of this new zoning offers a showcase to the metropolitan population the benefits of this creative zoning approach that allows increased density, and in many circumstances legitimizes what is already happening in major urban areas illegally.

The new accommodation will incorporate the latest in energy efficient construction approaches for new and retrofit construction, an efficient mechanical system that will be an upgrade of the present house mechanical, and carefully chosen interior finishes a healthier indoor environment will be used.

The project (it happens to your editor's newly acquired residence) will be done with the participation of the Greater Vancouver Home Builders Association Renovation Council, and will be used as part of the Council's public education program. Public open houses, seminars, and media coverage are part of the outreach activity planned. *Solplan Review* will document the construction process.



Staff at the City of North Vancouver have also expressed an interest in the project, as it will assist with the dissemination of information on new ideas and options for home renovations, and adaptation of homes for new uses. There are many older homes in the vicinity of the project, and there is a lot of desire to maintain the heritage of the older buildings (a number of which are designated heritage homes).

At press time we were waiting to hear if this project was going to be accepted as a CMHC Reno-Demo project.

The proposed work

The work will be done in two phases. The first phase is the development of a new 800 sq.ft. grade level suite in the basement, plus modest air sealing of the remainder of the existing house. The mechanical system (heating, domestic hot water, and ventilation) will be upgraded, using new energy efficient equipment. The second phase, to be done in the future, will be a more comprehensive energy upgrade and restoration of the main floor of the house.

We are presenting an overview of the proposed work. Details are still being finalized.

Energy Consumption

A preliminary energy analysis using the HOT-2000 computer program shows that the estimated annual energy consumption for the house, with addition, can be reduced by 60%.

Exterior walls:

Existing house walls are 2x4 framing; the proposal is to upgrade the walls to R-20+: the existing basement wall will be furred out on the interior. Two options are being considered for the new construction in the addition. One is 2x4 with 2" rigid sheathing insulation; the second option is stressed skin panels.

Windows:

The existing windows are either single glass in wood frame, or double glass (1/4" air space), aluminum spacer bars, in a non-thermally broken aluminum frame. It is proposed to use at least double glazed, low-e, gas fill, insulating spacers in wood or vinyl frame for the new suite. A similar window upgrade will be used for the second phase.

Floor:

The conventional local approach for this type of project is an uninsulated concrete slab. It is proposed to insulate the concrete slab, with a minimum of 3" rigid insulation (R15); plus R10 along perimeter. We are also planning to use polystyrene insulation formwork for new foundation walls in the addition.

Lighting:

It is proposed to take advantage of new compact fluorescent and low voltage halogen lighting.

Domestic hot water:

The existing naturally aspirating gas fired hot water tank will be replaced with a new high efficiency direct vent gas fired unit, possibly preheated by a batch solar water heater.

We hope to be able to make use of this new hot water tank to provide the space heating for the house as well as replacing the existing older naturally aspirating gas furnace. A fan coil blower unit would be used to draw heat off the hot water tank to service the upper suite, through the forced air system.

The proposed heating for the new basement suite is floor radiant heating, also taken off the domestic hot water tank. The split system is being proposed to provide a separation between the suites thus reducing acoustic separation problems and cross contamination of smells.

Ventilation:

A new heat recovery ventilator is being proposed to serve both the existing house and new suite. Ventilation for the existing house to be tied into the forced warm air system; for the suite it will be a dedicated supply system.

Interior Finishes

It is proposed to make use of low emission materials and finishes to reduce the pollutant load in the dwelling.

Work is scheduled to start this month. We will keep readers posted on the progress of the project, including what we do and how the decisions were made.

This is Resource Efficient? Affordable?

In preparing for some talks recently, I came across some very interesting information published by the World Watch Institute. It graphed the average size of new homes in the USA. It's not just the total square footage that is important, but also how much area per person is used. The figures are summarized in the following table.

When I hear discussions about affordability of new homes, a serious issue to be sure, I never hear any mention about the size and amenities in the home. I think the table sums up what has been going on, and why house prices have gone up.

If we are truly concerned about affordability, we should be concerned about the size also! RK.

Average size of new homes (USA)		
Year	Average house floor area	Average floor area per person
1945	1000 sq.ft.	320 sq.ft.
1965	1500 sq.ft.	430 sq.ft.
1985	1700 sq.ft.	650 sq.ft.
1990	1900 sq.ft.	800 sq.ft.

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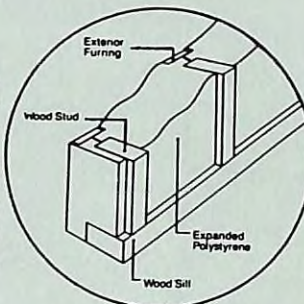
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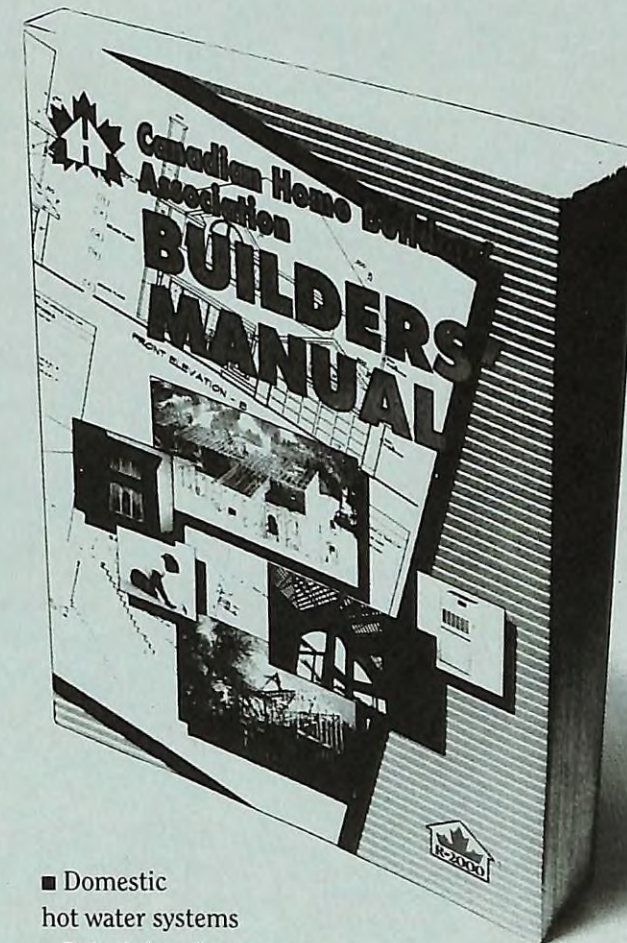
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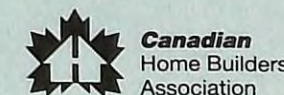
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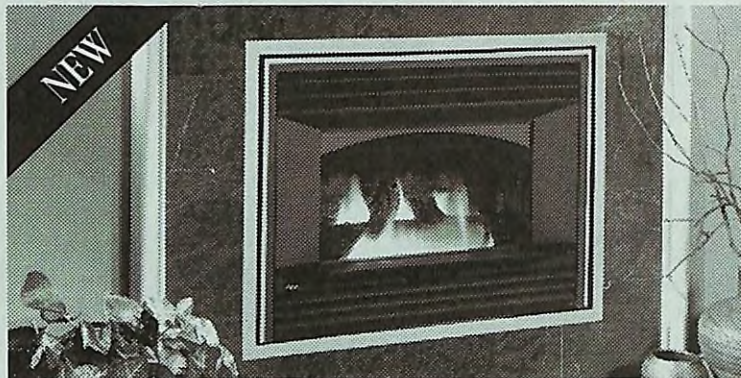
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